



THE IN-CAR EXPERIENCE

Axis Innovation Industry Report

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INTRODUCTION

The automotive industry is undergoing a dramatic period of change. New technologies and changing consumer preferences are transforming what a car is, how we own or share it, and what we do while we are inside. Traditional business models are being disrupted at an unprecedented pace, with more than 50% of global automotive ecosystem revenues expected to be in “disrupted” business areas by 2030.¹ We are starting to see the creation of exciting ecosystems in the automotive world with new players, novel business models, and large profit opportunities up for grabs. One of these areas is the in-car experience.

While a majority of attention is focused on the race to develop electric and autonomous vehicles, another race is heating up for the best in-car experience. Electric and autonomous technology will change *how* we drive (or are driven), but in-car technologies will change *what* we do in the car. This question of *what* is one of the major challenges and opportunities of the automotive industry today that deserves a thorough understanding and analysis.

Inside the vehicle, both hardware and software innovation are converging to dramatically change both how we interact with the car and how we’ll spend our time in the vehicle. Connectivity and autonomous technology will enable the car to become a platform for drivers and passengers to use their transit time for personal activities such as new media and business services, and regain as much as 50 minutes a day for the average driver.² The revenue potential is extraordinary - a report by McKinsey estimates global digital-media revenues of €5 billion per year for every additional minute people spend on the mobile Internet while in a car.³ For automakers,

the experiences they provide in the car is fast becoming one of their main marketing points and a key factor for people deciding which car to choose.

Understanding the trends and opportunities of the in-car experience today is critical for automakers and new entrants to the industry to differentiate their offerings, capture market share, open up new revenue streams, and provide the best possible mobility experience for their customers. In this Axis Innovation Industry Report, we’ll examine the historical steps that have brought us from the radio to the infotainment system and beyond. Then, we’ll break down the in-car experience into two major areas of innovation, software experiences and human machine interfaces (HMI). We’ll also explain the revolution of in-car audio and the introduction of health services, two major areas combining both software and HMI. In each of these categories, we’ll identify the major trends and technology breakthroughs, market opportunities, examples of automotive leaders and innovators, and highlight some of the most exciting startups in each field. Throughout the report, key insights are added to provide practical takeaways and strategies.

This report is based on our first hand experience as innovation consultants for major automakers and business development work with startups since 2013, combined with industry research and interviews with leading automotive ecosystem players. Our goal is to provide a valuable guide for automakers, startups, and new entrants to navigate the challenges and opportunities of the in-car experience.

Ready? Let’s go!

¹ Mobily’s Second Great Inflection Point, McKinsey & Company, February 2019

² Autonomous Cars: The Future is Now, Morgan Stanley, January 2015

³ Ten Way Autonomous Driving Can Redefine the Automotive World, McKinsey & Company, June 2015

PART 1: IN-CAR HISTORY

Let's start by taking a brief look at how we got here - beginning nearly 100 years ago.

For most of the 20th century, the greatest innovation of the in-car experience was the car radio - what can be called the first connected device in the car. Chevrolet was the first company to introduce an in-car radio in the late 1920's. At the time it was neither cheap nor practical - it had an aftermarket cost of \$200 (around \$2,700 today) and the antenna covered most of the roof of the car while the radio and speakers filled significant passenger space.⁴ But people were fascinated by the ability to combine radio with their transportation, and the idea of entertainment in the car was born.

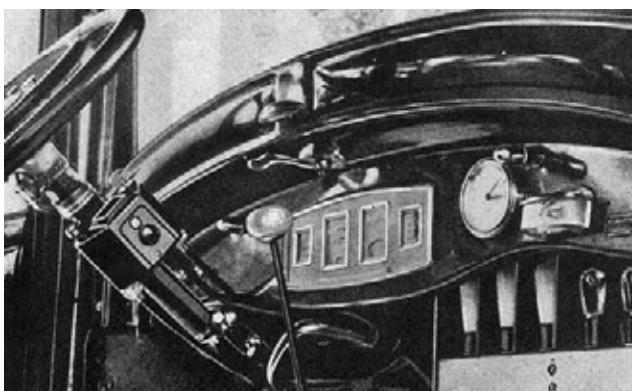


Image: Early car radio
Source: Radio Museum: First Car radios

In the ensuing decades, prices of radios continued to drop and the technology became streamlined. In 1952 FM radio was introduced, and by 1963, more than 60 percent of all the cars on the road were outfitted with radios and about one-third of all radio listening was done in the car.⁵ In the 1980's and 90's, cassette decks and later CD players became mainstream audio for cars, followed in the early 2000's with the advent of satellite radio companies Sirius and XM.

But it wasn't until the mid 2000's and the advent of smartphones that the in-car experience truly changed, thanks to software apps.



THE EVOLUTION OF THE IN-CAR EXPERIENCE

- 1922** ● Chevrolet introduced first in car radio
- 1930** ● Paul Galvin, founder of Motorola, invented affordable new in car radio
- 1952** ● Blaupunkt, German electronics company offered first AM/FM radio
- 1965** ● Ford and Motorola jointly introduced the 8-track tape in-car tape player
- 1969** ● Becker introduced first car stereo with 2 speakers
- 1981** ● Toyota and Honda introduced first in car navigation system
- 1984** ● Pioneer introduced the CDX-1, the world's first car CD player
- 1986** ● First in car touchscreen device by Buick
- 1996** ● GM introduced OnStar providing in-vehicle communications and services
- 2001** ● XM and Sirius Satellite Radio Launched
- 2002** ● Touch screen systems with GPS and music capabilities started gaining popularity
- 2007** ● Ford Sync released, which enabled hands-free calling and music controls through voice control
- 2009** ● Bluetooth technology factory installed in cars by majority of car makers
- 2012** ● Tesla Model S released with comprehensive touch screen infotainment system to control all car functions
- 2014** ● Google and Apple Launch Android Auto and Apple Car Play
- 2016** ● SDL (Smart Device Link) Consortium established
- 2017** ● Distracted driving is the third leading cause of death among drivers
- 2019** ● Majority of new cars are internet connected

⁴ A Short History of the In Car Radio, Nationwide Insurance, April 2017.

⁵ A Short History of the In Car Radio, Nationwide Insurance, April 2017.

PART 2: IN-CAR APPS

2.1: Smartphone Apps & Distracted Driving

Smartphone apps presented an exciting opportunity for consumers to bring new experiences into the car, as well as consolidate many traditional car features like radio, music, and navigation. There are several important reasons for this. Because any software developer could create an app in the Apple App and Google Play Stores - as opposed to the infotainment system which was initially only available to select developers - more and more apps were created that soon superseded the technologies and user experience available in the built-in infotainment system. As smartphone adoption reached critical mass in the late 2000's, people started to use their phones everywhere, including inside the vehicle. Very quickly, the user experience and features of smartphone apps became far better than what was in the offered infotainment system. Despite a larger screen and safer interface built for driving, the infotainment system's poor user experience and lack of enough apps led drivers to prefer their

smartphone for everything in the car, even apps which they shouldn't be using while driving such as texting, Facebook, emails, and others.

As a result, distracted driving - the act of driving while engaging in other activities which distract the driver's attention away from the road - became increasingly common and deadly in the early 2000's and onwards. Since 2012, over 3,000 people each year have been killed in the U.S. alone due to distraction-related crashes, which has become the third leading cause of automotive fatalities.⁶ Governments around the world responded by passing legislation related to holding phones while driving and initiated large education campaigns. Unfortunately these steps have had little impact on their own. Technology was also needed to provide alternative solutions to safely using phone apps in the car.



⁶ Distracted Driving Overview, National Highway Traffic Safety Administration

2.2 Axis Analysis: The Industry Response

The combined forces of smartphone app usage and distracted driving pushed automotive companies to offer better solutions themselves. For over 80 years automakers had complete control over the in-car experience - now for the first time thanks to smartphones and tech companies, they were being challenged by outsiders.

As a first step, automakers began “insourcing” - creating new internal divisions and teams to build better infotainment systems and native applications. The industry began to put more importance on software development and integration with smartphone apps, and hiring and training more software developers to create new solutions. While this is a necessary step that all automakers have taken, many are also “outsourcing” - and seeking to partner with external companies to complement their internal work.

Here in this report, we will focus on the outsourcing aspect of innovation, more commonly known as Open Innovation. After studying over 30 automakers and their strategy with software outsourcing, we have identified two approaches: (1) Work directly with the dominant tech companies Apple and Google to bring smartphone apps into the infotainment system seamlessly (2) Work with startup developers to create a custom app interface and unique app integrations. Practically all car companies have taken option one and partnered with Apple and Google, while a select but growing number are also creating their own apps and experiences through direct relationships with startups and developers.

THE BATTLE FOR THE IN-CAR EXPERIENCE WHICH OPEN INNOVATION SOLUTION SHOULD AUTOMAKERS CHOOSE?

STARTUP SOLUTION

AUTOMAKERS WITH EXTERNAL DEVELOPER PROGRAM



BENEFITS

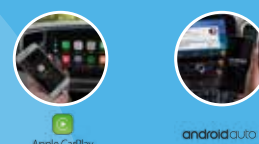
- Create direct relationships with startups & developers
- New potential revenue streams
- Potential for best user experience (UX) and user interface (UI) in the car

CHALLENGES

- Increased cost & resources
- Low familiarity; slow adoption

TECH SOLUTION

SMARTPHONE CONNECTED EXPERIENCES



BENEFITS

- Easy Integration & partnership
- Reduced developer cost & resources
- Meets Consumer demands & expectations

CHALLENGES

- Less control over apps and data
- User experience can be less optimal

2.3 Partner with Apple and Google

In 2014, Apple and Google launched their versions of phone-to-car sync: Apple CarPlay and Android Auto. Through these programs, drivers can sync their phone onto compatible car infotainment systems to use select apps in the car, as opposed to relying on the small smartphone screen. Drivers can also listen and respond to text using voice controls, in-car searches for nearby places, and navigation services. As of 2019, nearly every major automotive company has adopted this approach as a baseline, with over 500 car models compatible with both systems.⁷

Working with Apple and Google has significant benefits. Automakers have historically focused on building cars - not on providing software

apps or connectivity solutions. As a result, many automakers lack the development expertise of Apple and Google, and would prefer to work with them as opposed to building solutions from scratch. Apple and Google have nearly universal user adoption amongst consumers and provide a familiar and easy user interface which drivers have grown to expect. By syncing approved smartphone apps to the infotainment system, they make app usage much safer and can decrease driver distraction. However, they also have a major downside for automakers, as they lose control over the experiences offered and revenue sources from app usage.



Image: Apple CarPlay



Image: Android Auto

⁷ Apple CarPlay, www.apple.com/ios/carplay/available-model/; Android Auto, www.android.com/auto

2.4 Partner with Startups and Developers

A growing minority of car companies have chosen to work directly with developers to customize apps for the in-car experience and differentiate themselves. These companies have evolved quickly to become more software oriented and startup friendly. For example, they have created open API's (Application Programming Interface), giving developers unique access to car data and the ability to design apps directly for the car.

There are benefits of this approach to all sides. For automotive companies, they are creating a direct relationship with mobile startups and developers, as opposed to relying on Apple or Google as the middlemen. This helps achieve a major strategic goal - position themselves not just as automotive companies but as technology companies in the new world of mobility. Through these direct relationships with startups, they gain critical early stage

access to new ideas and key understanding of technology and market trends. This also helps them build better relationships with their end customers - drivers and mobility users - to provide a more customized and personal service, and open up new revenue streams from software.

For startups and developers, they are provided with unique access to car data and systems, something not available to Apple or Google, allowing them greater freedom and creative potential. For consumers, the end result can be a user experience far better than a traditional infotainment system, smartphone app, or even with Apple CarPlay or Android Auto. Moreover, drivers are provided with a new category of apps built for the driving experience - as opposed to smartphone apps which are built for the phone and only adapted for the infotainment screen.



Image: Ford SYNC 3 system

2.5 Case Study: Ford AppLink and SDL

Several major automotive companies that have adopted this proactive approach with startups and seen success. One of the first automakers to do this was Ford, which in 2013 launched **AppLink**, aimed at giving developers an opportunity to customize apps specifically for their cars. To date the Ford Developer Program has over 15,000 developers and an ecosystem offering a wide variety of approved apps. With these selected apps drivers can use custom voice commands, steering wheel buttons, or a combination of the two to control features. With AppLink, app developers have far greater customization potential and features to offer drivers. For example - using the **Pandora** music app on AppLink, a driver has a dozen custom voice commands (such as "Bookmark" to bookmark current track, "Thumbs up" to like a track, and more - things not possible with Apple CarPlay or Android Auto). Another recent app to join their ecosystem is Acast, a popular podcasting app. As described by **Acast** in an interview about why working with Ford was different than Apple or Android, "Although Acast has developed for Android Auto and CarPlay, working closely together with Ford opened many

experience and making use of voice features... and a better end product for drivers."⁹

Besides the improved product for driving, startups can benefit in other ways. By developing directly for an automotive company, they can get their app exposed to millions of drivers and generate great publicity. The company **HearMeOut**, which partnered with Ford AppLink for their voice-based social network, saw their share price surge more than 30% after Ford expanded their app to cars in the US.¹⁰

Following the growth of AppLink, Ford decided to open-source the technology and created the **SmartDeviceLink (SDL)** in 2016, a consortium of automaker's including Ford, Mazda, Subaru, Suzuki and Toyota and even tech companies like Amazon. SDL provides software tools for automakers to create highly integrated connected experiences, and offers app developers new and exciting ways to connect with consumers. Their goal is to make SDL the industry standard for in-vehicle application connectivity.¹¹



Image: Ford developers working with startups at the Ford Make it Driveable 2018 Challenge, organized by Axis Innovation in Tel Aviv.

⁹ Interview with Acast, www.developer.ford.com/pages/acast

¹⁰ HearMeOut gets boost from Ford US approval, SBS News, August 2017

¹¹ Smart Device Link Overview, www.smartdevicelink.com

2.6 Additional Automaker Programs

In recent years, several other automakers have created their own programs or ecosystems for developers.

General Motors: GM Developers is an advanced program for developers to start developing for GM vehicles. They provide tools to access close to 200 data points, emulators for specific software languages, and a dedicated Android platform. They are open to any app developers, and provide a testing and certification process to test the app in a real world environment.¹²



Image: GM programs to engage app developers

Volkswagen:

While Volkswagen does not yet have an external developer program, they have made headlines by declaring to grow their technology workforce to as many as 10,000 developers. This is part of a broader strategy to invest \$9 billion in software investments over the next three to five years to unite all their software systems under a new operating system called “vw.os”, with the goal to bring their software development to a higher level and compete with Apple and Google.¹³



Image: Volkswagen trains further software developers, www.volkswagen-newsroom.com/en

Mercedes-Benz: Mercedes created Mercedes-Benz /developers, a public API platform opened in 2017. They offer several API products for developers to use, giving them unique access to car data with the goal to spur the development of innovation applications and new business models. They recently announced they have 2,000 registered developers. Besides regular products, developers created the Hack.IAA event, a 24 hour hackathon providing developers unique access to Mercedes-Benz Mobile SDK (Software Development Kit), with customer data and vehicle functions needed to develop new mobile apps for Mercedes-Benz cars.¹⁴

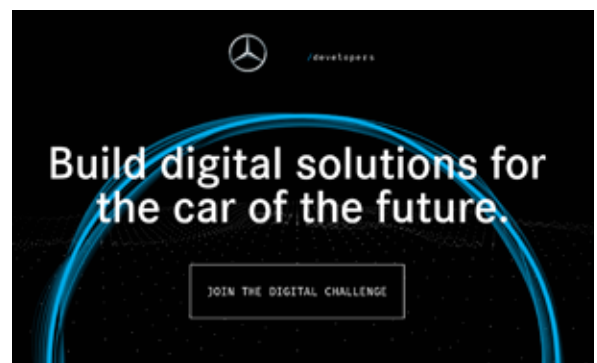


Image: Mercedes-Benz /Developers Program.

BMW: BMW created BMW Labs, a program open for users to test BMW's latest connected and digital services. As part of this, they have created several services including the Online Apps Platform and Hackathon. This event calls for app developers to build next generation solutions for payments in the car, location based services, education, sustainable driving, and digital stores.¹⁵



Image: BMW's latest Head-Units, running their onboard software platform Online Apps Platform (OAP).

¹² GM Developers Program, www.developer.gm.co

¹³ Volkswagen trains further software developers, www.volkswagen-newsroom.com/en

¹⁴ Mercedes-Benz / developers, www.developer.mercedes-benz.com

¹⁵ BMW Online Apps Hackathon 2019, labs.bmw.com

2.7 Axis Insights: Key App Categories

We have identified 3 main categories of apps with the greatest opportunity for growth: **entertainment, driving & navigation, and productivity**. Entertainment and navigation represent the traditional experiences drivers have in the car, boosted by new technologies and interfaces. Productivity is a new category of experiences that have recently entered the vehicle, and encompass a broad range of services that can revolutionize what we do in the vehicle. Not only do these experiences add value to their customers - both consumers and fleets - they also represent new potential revenue streams for automakers, media companies, and startups.

Entertainment:

Entertainment for the driver are apps that provide positive entertainment for the driver to consume and make the drive more enjoyable. These include music, podcasts, radio, touring information, learning new things/skills, games for passengers, social networks, and even video (in future semi and fully autonomous vehicles).



Image source: www.wrenmcdonald.com

Driving & Navigation:

Apps that help drivers get to their destination safer, faster, or with travel related experiences. These include navigation, parking, ride sharing, smart hitchhiking, driver coaching and monitoring, car maintenance, gas fueling, fleet logistics and tools, and communication between driver and car.



Image source: www.judebuffum.com

Productivity:

Help drivers integrate lifestyle Apps that integrate lifestyle, work, or shopping into the car experience, thus offering a new value for the driving time. This includes calendars, email, business apps, food ordering and delivery, and payments.



Image source: www.harrycampbell.net

2.8 Software Apps & Connectivity

The connection of smartphones to the car infotainment system - whether through Apple and Google or through an automaker's program directly - is an important step bringing new types of digital content and services into the car and enabling a more exciting, engaging, and safer drive. But connection from the phone is just the beginning of a greater technology trend - the growth of in-car connectivity and the birth of the "connected car." No longer limited to our phones we bring into the car, connectivity now comes with the car itself. The number of cars with SIM cards and built in connectivity coming into the market is rising rapidly, with nearly every major car company offering wireless online connectivity in some vehicles. In 2020, a majority of new cars from premium to basic will come with built in connectivity.¹⁶

Greater connectivity is critical to enabling new types of in-car services and experiences. Instead of relying on the phone for connectivity and apps, now experiences can be beamed-in directly to the car without using the phone at all. This opens up new types of experiences created specifically for the car, and enabling automakers to create and manage the ecosystem of apps and services available inside the car. In addition, connectivity is a massive new business opportunity. Vehicle data alone - a new market born out of vehicle connectivity - could represent a value pool of up to \$750 billion by 2030.¹⁷ Recurring revenues in the automotive industry are expected to grow from a mere \$30M in 2015 to a massive \$1.5B in 2030 - representing a 30%+ CAGR. A large part of these revenues are from data services including apps, navigation, entertainment, and new software services.¹⁸



Image source: Shutterstock

¹⁶ An overview of Connected Cars and the Automotive Industry, Mavoco

¹⁷ Accelerating the Car Data Monetization Journey, McKinsey & Company, March 2018

¹⁸ Automotive Revolution - Perspective Towards 2030, McKinsey & Company, page 6

PART 3: HMI

3.1 Background

The abundance of new apps and advanced technologies in the car has fueled the development of innovative ways we interact with the car itself. While the previous section dealt with apps and experiences brought from the car to the driver, this section will deal with the opposite direction - how the driver communicates with the car.

For nearly 100 years we used basic switches and dials to interact with the vehicle, but now cars offer advanced human machine interfaces (HMI) including displays, audio technology, sensors and cameras all combined with artificial

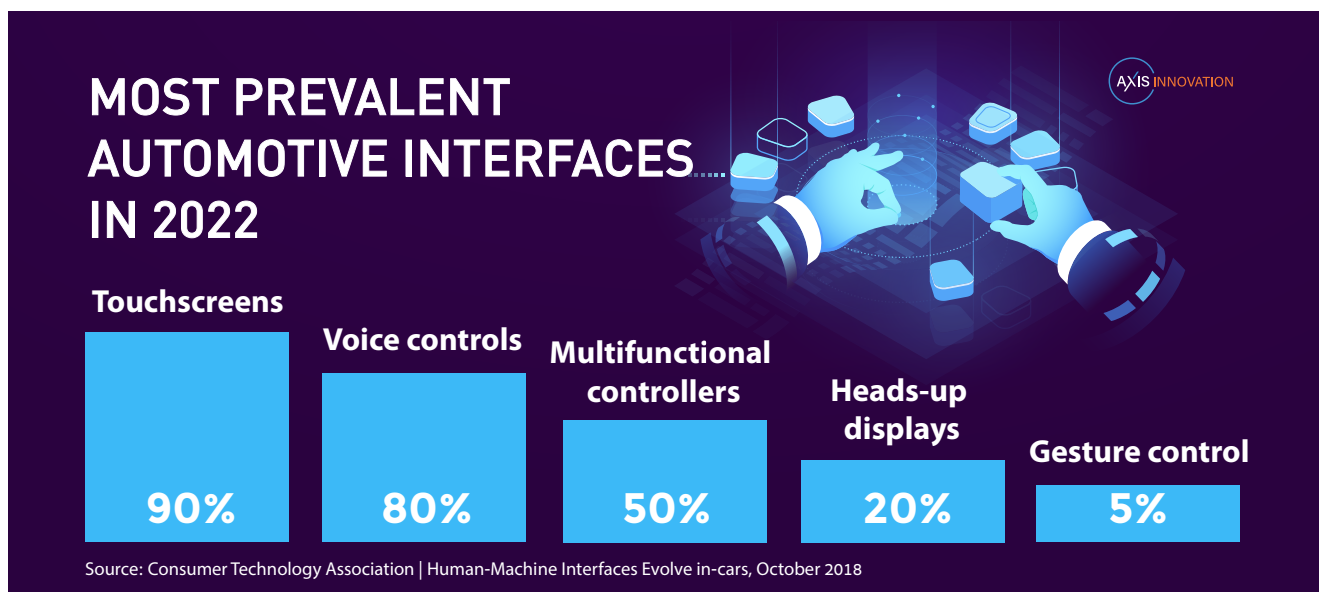
intelligence and computing platforms. While it sounds complicated, these systems are built with the specific purpose of making the in-car experience simpler and easier for everyone to use, from tech savvy millennials to baby boomers. They also offer significantly better user experience and safety thanks to less distraction and a more seamless driving experience. As we evolve from doing everything in the car ourselves to semi and fully autonomous vehicles, new types of in vehicle HMI will be critical to the in-car experience and open exciting new business opportunities.

3.2 Axis Insights: HMI Categories

After studying over 30 automakers and tier 1 Suppliers as well as over 500 automotive startups, we have identified the major in-car HMI technologies and their business opportunities. In this section, we will break down HMI into 5 main categories and explain and elaborate on each: Touchscreen, Voice, Gesture, Heads Up Display (HUD), and Audio.

We will also discuss Health and Wellness - a critical new area of automotive utilizing advances in HMI. In each section, we have selected top Israeli or European startups as leaders in the category, and will share their key innovations and potential for disrupting the in-car experience.

All forms of HMI are expected to grow in adoption, as can be seen by the chart below.¹⁹



¹⁹ Consumer Technology Association | Human-Machine Interfaces Evolve in-cars, October 2018

3.3 Touchscreens & Infotainment Systems

Where buttons and dials previously mediated the driver and passenger's interaction with multimedia and infotainment, touchscreens have become the industry standard, dominating the market share for HMI systems. While the first in-car touchscreen system was introduced way back in 1986 into the Buick Riviera,²¹ advanced infotainment systems - a touchscreen with navigation, radio, car functions, and more - became mainstream across automakers in the mid-2000's. As we look towards the future, touch based systems are predicted to be the most prevalent interfaces in 90% of vehicles by 2022.²²

As the demand for new types of experiences and services grow - and we move towards semi-autonomous and fully autonomous vehicles - future infotainment systems will be even more advanced and central to the in-car experience. Several new car companies have already begun to push the boundaries of mobility through digital transformation. **Tesla** was the first car company to make the infotainment system the central hub of all features of the car. All of its models have large central displays that handle every vehicle function possible, as well as apps and entertainment features. **Volvo's Polestar 2**, released in 2019, is the first car to include Google Native Dashboard - a new interface purposely built by Google for the in-car screen. And no discussion about infotainment screens would be complete without

discussing **Byton** - a new startup car company launching in 2020 with a massive 48 inch screen crossing the entire dashboard, alongside a 7 inch touchpad screen on the steering wheel.



Image: Byton M-Byte Interior and Infotainment System

Startup Spotlight

With the infotainment screens growing larger and with more options, it can pose a greater risk of driver distraction. The startup company **Inpris** has developed an innovative technology solution for this. Inpris develops Sightless Touch, a distraction-free human-machine interface technology that enables eyes-free touch control. The technology maps the hand of the user and assigns each finger a specific role within their car's multimedia system. By using different fingers for different interactions and adapting the screen to the user's finger location, Sightless Touch enables its users to control the infotainment system without looking at the screen. Their technology can be integrated within an automaker to advance the user experience of the touchscreen, as well as an aftermarket version.



Image: Tesla Infotainment System

²¹ Tech Before it's Time: 30 years ago Buick put the First Touchscreen in a Car, CarBuzz, March 2016

²² Global Connected Car Market Outlook Report, Frost & Sullivan, 2019

3.4 Voice: Changing Communication In The Car

Voice controls based on speech recognition are a valuable tool for automotive HMI. More than half of new cars on the road in 2020 will integrate voice technologies such as voice recognition, speech-to-text and text-to-speech to enable drivers to control entertainment and automotive functions with their voice. While this technology has been around for years already, they suffer from historically low accuracy, leading to frustration amongst drivers and slow adoption. Background noise, speech accents, and a handful of other limitations have challenged the efficiency of voice. In order for voice controls to be an integral part of automotive HMI, voice systems must not only become much more accurate but also smart, conversational, and personalized.

While all automakers have their own voice technology built in the car, both large companies and startups are entering the voice arena as well. Amazon released **Alexa for Vehicles**, providing an automaker and aftermarket solution to integrate Alexa's intelligent voice service into vehicles. With Alexa for Vehicles, drivers can ask Alexa to play music, listen to audiobooks, hear the news, check the weather, control smart home devices, get directions, find parking, and more – all while they keep their hands on the wheel and eyes on the road. At the same time, Alexa Auto can help users control their vehicle from their home such as locking the doors, adjusting cabin temperature, and more. Alexa is already integrated with hundreds of automakers through in-vehicle integrations, and also offers integration through aftermarket Alexa-enabled bluetooth devices.

Startup Spotlight

Intuition Robotics has developed breakthrough AI (artificial intelligence) technology redefining the relationship between cars and people relationship. Their technology acts like a personal assistant to the driver, allowing the in-car companion agent to become context-aware, proactive, personalized and adaptive, and creating a bi-directional interaction that will generate a deeper relationship between the user and the car. Alternatively, health is a totally new category that has the potential to make the in car experience a critical part of our greater well being. They recently announced an investment from Toyota and major collaboration with the Toyota Research Institute (TRI). Intuition Robotics is an example of the growth of AI technology and importance of personalization for the in-car experience.



Kardome is attempting to solve the voice accuracy problem by developing a multi-user speech to text algorithm that hones in on a person's individual voice while drowning out wind noise or background music. This helps to create a more optimized voice recognition system for cars.



3.4 Gesture and Eye Recognition

Gesture recognition - understanding human gestures without touching a screen - is expected to be the fastest growing segment and the next generation of HMI. A market study conducted in 2018 by Global Market Insights forecasts the automotive gesture recognition market size to grow from \$1.1 million in 2017 to \$13.6 billion by 2024.²³ Using this technology, for example, a driver can wave their hand to turn up or down volume or control any predefined features in the car. While this technology is relatively new, it has appeared in several high end models, such as the BMW 7 series since 2016 and Mercedes S-Class. As it becomes more mainstream in the coming years, gesture recognition can be another valuable tool to help reduce distracted driving. If gesture technologies can help drivers keep their eyes on the road while performing basic functions such as adjusting volumes, music, air flow, answering phone calls, and more, it holds great potential for both greater safety and a more natural in-car experience.

Startup Spotlight

EyeSight is a leader in the gesture recognition and computer vision space creating intelligent sensing systems for the in-car environment. Through sensing and gesture recognition technology, based on Infrared or Time of Flight (TOF) sensors, EyeSight's automotive solution addresses three main aspects of the in-car experience: Driver Control, Driver Monitoring, and Driver Identification. Driver Control is a solution which augments the infotainment interface with touch-free gesture control. Gestures include finger, palm, swirl, and others for controlling infotainment functions. Driver Monitoring and Identification uses eye control to identify a driver or passengers state (such as if the driver is drowsy, turning eyes off the road frequently).



Image: Eyesight Technologies, www.eyesight.com

²³ Automotive Gesture Recognition, Global Market Insights Report, 2018

3.5 Heads Up Display (HUD)

Not only are the ways in which we interact with car interfaces shifting dramatically, but so also are the displays themselves. Augmented-reality Heads Up Displays (HUDs), projections on the windshield that display certain relevant information (such as navigation information) to the driver, are aimed at shifting the focus of the driver to the roads and away from a central console system. While luxury vehicles were the first industry players to have already implemented these systems, the market is expected to grow from \$1.3 billion in 2018 to \$4.7 billion by 2023, growing at a CAGR of 29.9% during the forecast period. New types of HUD offer large benefits for drivers to keep their eyes on the road for traditional navigation, as well as integrate new experiences like shopping, tourism, and more.²⁴

Startup Spotlight

WayRay developed the first holographic AR navigation system for cars. The information displayed is seamlessly integrated



into the real world, allowing the driver to focus on the road and making driving safer. WayRay also integrated gesture control technology into their system. In 2018, the company announced a \$80M fundraise led by Porsche alongside Hyundai Motors, Alibaba group, and other key strategic investors, and plans to bring its technology to market by way of Tier 1 partnerships.

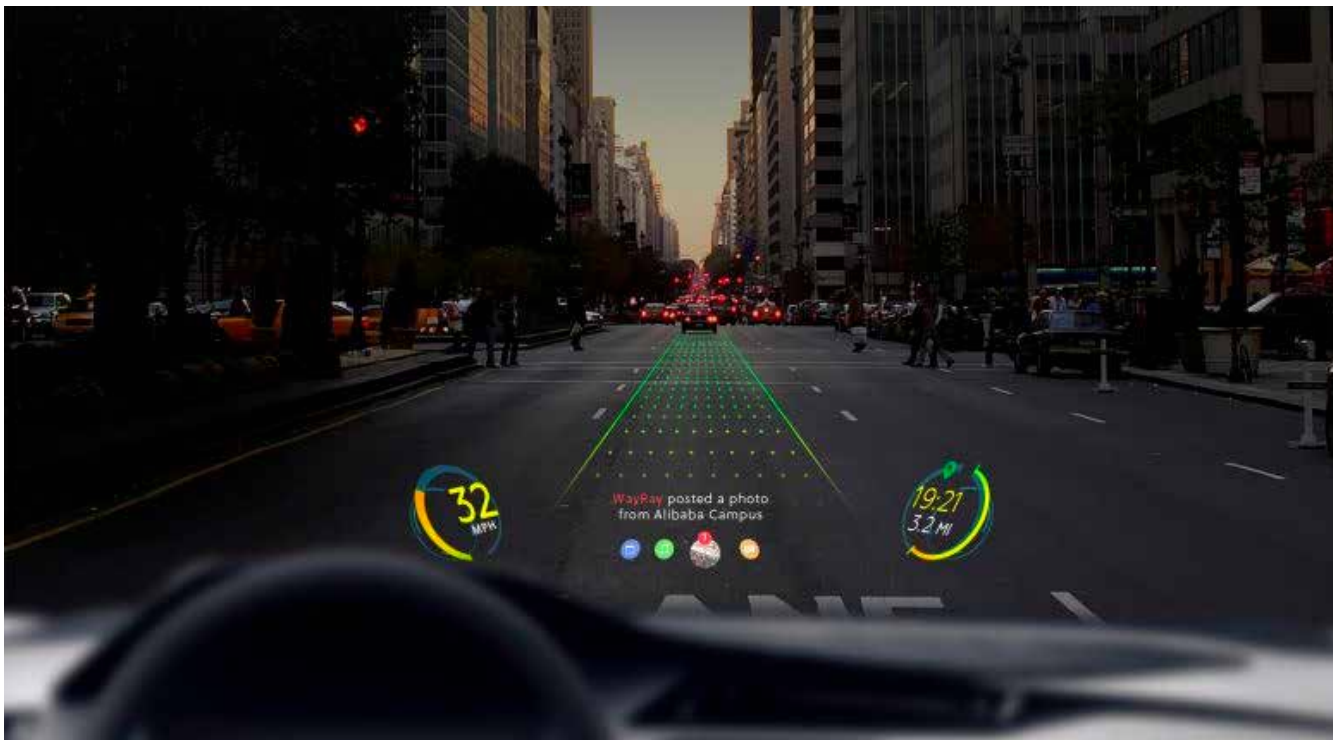


Image: WayRay Creates Holographic Navigation, www.wayray.com

²⁴ Head-Up Display Market Report, Marketsandmarkets.com

PART 4: AUDIO & HEALTH

4.1: Future Audio Experiences

While we have always had audio in the car cabin, the way we listen will dramatically change. Alternatively, health is a totally new category that has the potential to make the in-car experience a critical part of our greater well being.

Safer and smarter cars have also pushed a demand for higher-quality audio experience for music, media, and communications. In a quieter electric and future autonomous car, noises from outside the car such as traffic, weather, and vibrations can become more invasive. Noise cancellation systems, speaker positioning and power, in conjunction with voice command technology is driving innovation in-car audio. This includes both hardware and software innovations that are changing the way we consume audio in the car. In-car audio is already a massive market, led by audio giants such as Bose, Harman, Panasonic, Sony, and others. However, many startups have also entered the field.



Image: Noveto technology, www.noveto.biz



Image: Silentium technology, www.silentium.com

Startup Spotlight

Silentium is tackling the noise problem by creating innovative noise reduction products. The technology generates an anti-noise



signal that reduces troublesome noise in a number of environments. The technology is called the "quiet bubble" because it allows the creation of a quieter space around the user, regardless of the source of the noise.

Two startups personalizing the audio experience in the car are Noveto and Tunefork. **Noveto** has



"virtual headphones" designed to transmit sound emissions that target passengers ears so that relevant sounds are broadcast to only those who need to hear it. For example, a driver can hear specific navigation instructions while passengers each hear their music preference - all without any headphones or cables.

Tunefork customizes audio sound to each person, specifically for those with hearing aids and seniors.



Through a simple hearing test, their technology grades the user's specific hearing problem. The test results, paired with sophisticated algorithms to adjust frequencies, create an optimal, custom-made audio experience for the user – a personalized Audio Profile. While Tunefork works with any smart or connected device, they hold enormous potential for the car to improve navigation and are in discussions with leading automakers to integrate their technology for in-car audio.

4.2 Health and Wellness

A further application of greater computer vision and sensor technology in the car is for health. As cars become smarter and more aware, the industry is finding new ways for vehicles to monitor and engage the driver's health and wellness. Sensors in the steering wheel and seats, cameras with computer vision, AI analysis and other advancements will enable us to know more about driver's health than ever before. This movement corresponds with an ongoing and growing global health crisis that is demanding a new approach to healthcare - one that is proactive rather than reactive. The first applications for driver health have already been introduced to the market using existing sensor systems to monitor basic driver health. In the future, this technology will help cars have a more comprehensive understanding of the status of their passengers and drivers, helping enable safer driving and a more comfortable and personalized driving experience. In addition to consumers, a large part of the market for driver health will come from fleet and business drivers. It is forecasted that the market for healthcare and wellness in the vehicle will increase at a 67% CAGR (compound annual growth rate) from 2018 to 2026, and is expected to reach \$6.7 Billion by 2026.²⁵

All major car brands are eager to find ways to incorporate health as part of their in-car experience. Currently, several brands such as Audi, BMW, and Mercedes, as well as select Ford and Volkswagen models have introduced health solutions into their high end vehicles. Features include driver attention and drowsiness detection by using driving inputs, cameras, and biomedical sensors.²⁶ While basic health monitoring such as reconfigurable seats and mood lighting is present in a small percentage of new cars today, critical functionalities like blood pressure monitoring will penetrate nearly 5 percent of vehicles by 2025.²⁶

Startup Spotlight

Neteera utilizes deep technology for in-car driver monitoring. Founded by executives from MobileEye,



Neteera has developed a remote vital-sign monitoring technology that enables users to understand health, stress, attention, and other healthcare parameters by detecting major EKG and pulmonary metrics in a contact-free, continuous, safe, and cost-effective way. Neteera recently accounted a strategic partnership with the global Automotive Tier 1, Valeo, with the purpose of measuring heart rate and respiration rate of the driver.

MDGO's mission is to build the bridge between automotive and healthcare. By using existing sensors and



infrastructure in connected vehicles, their software solution can help save lives in car accidents by empowering first responders with a real-time trauma analysis report, describing injury type and severity for each passenger. In the case of an accident, MDGo delivers actionable and accurate medical information as soon as possible automatically to both first responders and trauma units. By more accurately guiding triage, on-scene and ER treatment, MDGo saves lives, decreases fatalities, reduces rehabilitation expenses, and mitigates liability claims. MDGo is FDA listed and CE marked and lists Volvo and Hyundai as investors and strategic partners.

²⁵ Global Automotive Active Health Monitoring System Market, Transparency Market Research, July 2018

²⁶ Global Automotive Active Health Monitoring System Market, Transparency Market Research, July 2018

²⁷ Convergence Trends See the Automotive Industry Integrate Health, Wellness and Wellbeing into Vehicles, Frost & Sullivan, 2015

PART 5: BEST PRACTICES

Axis Insights for startup - corporate collaboration

The challenges and opportunities presented by new in-car software apps and HMI's have brought many new players into the automotive ecosystem. Unlike in the past, when automakers compete only with each other, now they must also compete with tech giants like Apple and Google, startups, media companies, and more. But as the competition increases, so does the opportunity for collaboration. Automakers that will survive and thrive in this new era will be the ones that place partnerships and innovation at the forefront of their strategy.

In the past decade, more than a dozen automakers have actively entered the startup space, either through corporate venture capital arms, M&A activity, startup accelerators or other open innovation programs.

At Axis Innovation, we have identified 6 key open innovation strategies of the most successful automakers working with startups.



Image: Axis Innovation Startup Networking Event, 2019.

AXIS INSIGHTS: OPEN INNOVATION BEST PRACTICES

1 ESTABLISH A DEDICATED TEAM

Understanding digital trends, hardware and software, and working with startups requires a unique skill set not found in traditional automotive employees. Having a team responsible for the in-car experience is critical to find the right solutions and help bring their innovation to the right business unit.

2 COLLABORATION-FIRST STRATEGY

Automakers must not only partner with startups, but also with fellow automakers, media companies, tech companies, and others. Navigating this landscape requires a collaborative approach and openness to testing new ideas.

3 SCOUT GLOBALLY

Innovation is everywhere, making finding the right companies to work with a major challenge. Automakers must scout globally directly and work with local partners and consultants to stay aware of the latest relevant innovations and trends.

4 ORGANIZE EVENTS

Events such as hackathons, challenges, and meetups are a great way to engage with tech players and promote your company as startup friendly and innovative. They are also a low-cost, low-footprint way to establish connections in different ecosystems without needing a permanent presence in that location.

5 FOCUS

While there are endless new possibilities for digital products or services in the car, it is best to focus on 3-5 initial target areas. This gives enough diversity to explore different solutions but is specific enough to increase the likelihood of success in these areas.

6 MOVE QUICKLY!

Traditionally, it can take years to get a new device or product into a production car. Thanks to connectivity and in-car software platforms, it is now possible to work with startups quickly and test their products within a few months.

SUMMARY

The in-car experience has come a long way since the first car radio. Today, the digitalization of the vehicle cockpit with its large displays, internet connectivity, software apps, and diverse interaction capabilities enable endless new possibilities for experiences in the car. The increasing speed of innovation requires all sides of the automotive ecosystem - automakers, Tier 1 suppliers, tech companies, and startups - to work together in novel ways. Automakers must

continue to invest in better in-car technologies and solutions, as well as collaborate with startups and tech companies for innovative services and business models. We've entered a new era of automotive mobility where cooperation must be at the center of everyone's strategy. Companies that successfully do so will help shape the future of mobility in the 21st century, which is gearing up to be an exciting era driven by innovation in the in-car experience.



Jason is the COO & Dealflow Manager at Axis Innovation and part of its founding team. He works closely with Axis Innovation's automotive clients, startups, and partners on scouting, investments, and business development.

To learn more about our work in mobility and the in-car experience, contact jason@axisinnovation.com



Image: Ford Make it Driveable Startup Challenge Lisbon 2019, organized by Axis Innovation